Sorbent Injection for Small ESP Mercury Control in Low Sulfur Eastern Bituminous Coal Flue Gas

Quarterly Technical Progress Report

October 1, 2003 – December 31, 2003

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ABSTRACT

This document summarizes progress on Cooperative Agreement DE-FC26-03NT41987, "Sorbent Injection for Small ESP Mercury Control in Low Sulfur Eastern Bituminous Coal Flue Gas," during the time-period October 1, 2003 through December 31, 2003. The objective of this project is to demonstrate the performance of an activated carbon injection (ACI) process, configured upstream of a small-sized electrostatic precipitator (ESP), for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI and Southern Company are project co-funders. URS Group is the prime contractor.

The general ACI control concept is inject activated carbon directly into coal combustion flue gas upstream of a particulate control device. Mercury is adsorbed from the flue gas to the carbon that is subsequently removed by the downstream control device. The mercury is thus removed from the process with the captured carbon. In this program, tests will be performed at two sister units at Georgia Power's Plant Yates (Georgia Power is a subsidiary of The Southern Company) configured with small-sized ESPs, defined here as units with specific collection areas (SCAs) of less than 200 ft^2/1000 acfm of flue gas flow.

Parametric tests will be carried out on Units 1 and 2 to evaluate how sorbent type and injection rate affects mercury removal performance. Additional tests (Unit 2) will evaluate the effect of a fly ash conditioning system on sorbent removal of mercury. Mercury removal across the ESPs of both units will be evaluated. In addition, downstream removal across a wet FGD system on Unit 1 will also be evaluated. Results from short-term parametric tests will be used to select a sorbent material and determine optimal operating conditions for a 1-month long-term performance test on Unit 1. The objective of the long-term testing is to obtain sufficient operational data on removal efficiency over time, effects on the ESP and balance of plant equipment, and on injection equipment operation to prove process viability.

A primary objective of this sorbent injection program is to generate data to show the economic benefits of sorbent injection in a bituminous coal environment with an ESP or ESP/FGD configuration. The program is aimed at using low-cost sorbents. Data from this program will be used to perform an economic analysis of the costs associated with full-scale implementation of a sorbent-based injection system for these types of facilities.

This is the first full reporting period for the subject Cooperative Agreement. During this period, efforts included kickoff activities and initial planning for Site 1 testing. Work on the design of the Site 1 sorbent injection system was also started. This technical progress report provides an update on these efforts.

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INTRODUCTION

This document is the quarterly Technical Progress Report for the project "Sorbent Injection for Small ESP Mercury Control in Low Sulfur Eastern Bituminous Coal Flue Gas," for the time-period October 1, 2003 through December 31, 2003. The objective of this project is to demonstrate the performance of an activated carbon injection (ACI) process, configured upstream of a small-sized electrostatic precipitator (ESP), for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI and Southern Company are project co-funders. URS Group is the prime contractor.

Southern Company is providing co-funding and technical input to this project and its subsidiary, Georgia Power, is providing its Plant Yates as a host site for testing. Plant Yates (Units 1 and 2), fires a low-sulfur bituminous coal. Units 1 and 2 are configured with small-sized ESPs for particulate control. Unit 1 is configured with a downstream CT-121 Jet Bubbler Reactor (JBR) wet FGD system**.**

This sorbent injection technology is targeted as the primary mercury control process on plants burning low/medium sulfur bituminous coals equipped with ESP and ESP/FGD systems. Approximately 38,000 MW of generating capacity exist for bituminous coal-fired power plants with high-efficiency particulate control devices followed by wet lime/limestone FGD. In addition, about 70% of the ESPs used in the utility industry have SCAs less than 300 ft^2/1000 acfm. Current full-scale testing of sorbent injection systems on ESP systems has shown promising results; however, all of these tests have been conducted for high-SCA ESP systems. Therefore, the data from this sorbent injection project will be applicable to a large portion of the market and fill a data gap for the application of sorbent injection to low-SCA ESP systems.

This project will evaluate full-scale sorbent injection for mercury control at two units with low-SCA ESPs, burning low sulfur Eastern bituminous coals. Full-scale tests will be performed at Georgia Power's Plant Yates Units 1 and 2 to evaluate sorbent injection performance across a cold-side ESP/wet FGD and a cold-side ESP with a dual NH_3/SO_3 flue gas conditioning system, respectively. The sorbent injection equipment will be installed upstream of the ESPs at Unit 1 and Unit 2. Two weeks of short-term parametric tests will be conducted at Unit 1 with two different sorbents. The sorbent injection rate will be varied for Norit FGD carbon and one additional sorbent in attempt to achieve mercury removal rates between 40 and 90%.

Additional tests will be performed on Unit 2 with one sorbent to evaluate the effect of dual flue gas conditioning (for fly ash removal) on mercury sorbent performance. The results of the short-term parametric tests will be used to design a one-month injection test on Unit 1 to provide insight to the long-term performance and variability of this process as well as any effects on plant operations or ash/FGD byproduct composition. The total expected duration of the project is expected to be 24 months.

One of the purposes of the sorbent injection program is to generate data to show the economic benefits of sorbent injection in a bituminous coal environment with an ESP or ESP/FGD configuration. The program is aimed at using low-cost sorbents. Data from this program will be

used to perform an economic analysis of the costs associated with full-scale implementation of a sorbent-based injection system for these types of facilities.

This report describes the activities carried out for this program during the first project-reporting period, between October 1 and December 31, 2003. The remainder of this report is divided into four sections: an Executive Summary followed by a section that describes Experimental procedures, then sections for Results and Discussion, and Conclusions.

EXECUTIVE SUMMARY

Summary of Progress

The current reporting period, October 1, 2003 through December 31, 2003, is the first full technical progress reporting period for the project. Efforts during the current period focused on tasks associated with initiating and planning the test program. Specific activities included finalization of the project Statement of Project Objectives (SOPO) and Hazardous Waste Plan, project kickoff meetings, a host site survey, initial planning and scheduling for Site 1, and initiation of the sorbent injection design task for the parametric test program. Table 1 lists the planned and completed milestones for the first year of this project. A summary of each activity carried out during this reporting period is provided below.

Table 1. Schedule for Year 1 Milestones for this Test Program.

Milestone		Description	Planned Completion	Actual Completion
FY2004	1	Test Plan/QA Plan	Q1	
	2	Project Kickoff Meeting	Q1	Q1
	3	Site Survey (Yates Units 1 & 2)	Q1	Q1
	4	Initiate Parametric ACI Tests – Unit 1	Q2	
	5	Initiate Waste Analysis and Byproduct Evaluations	Q2	
	6	Complete Unit 1 Parametric Tests	Q3	
	7	Initiate Long-term Testing (Unit 1)	Q3	
	8	Complete Long-term test (Unit 1)	Q4	
	9	Initiate Site Report and Presentation – Unit 1	Q4	
	10	Initiate Parametric ACI Tests – Unit 2	Q4	
	11	Initiate Site Report and Presentation - Unit 2	Q4	
	12	Initiate Economic Analysis	Q4	

A final Statement of Project Objectives (SOPO) document for this program was prepared and submitted to NETL and distributed to the project team. This document summarized the plans for the test program including a list of parametric tests to be carried out at Plant Yates Units 1 and 2. In addition, plans for conducting a long-term performance test on Unit 1 along with planned analytical characterization tests were also described. A Hazardous Waste Plan for the ACI test program was also prepared and submitted to NETL. A draft Test Plan and Quality Control Plan was prepared during this reporting period. The final version of this plan will be issued during the

next reporting period pending final decisions made regarding test schedule and selected sorbents to be tested.

Two project meetings were held during this reporting period. A DOE Contractors' Meeting was held on November 20, 2003 in Pittsburgh to discuss all of the upcoming mercury control programs being carried out under this solicitation. A project-specific kick-off meeting was held the following day in Pittsburgh to discuss project objectives, schedules, and planned action items. Attending team members included NETL, EPRI, Southern Company, ADA-ES, and URS.

A site visit and survey was conducted at Plant Yates on October 23, 2003. All project team organizations were represented in the meeting. Discussions included program objectives, planned test schedules, expected on-site staffing requirements, health & safety issues, and issues related to process sampling. Additional discussions included expected plant support requirements including those associated with required utilities for testing and requested plant process data. Test locations for both units were walked down and required modifications for equipment installations were identified.

Project Planning and Scheduling

Initial project planning was carried out during this reporting period. This included determination of detailed testing activities summarized in the SOPO. Several adjustments were made to the project schedule. The current project schedule is listed in Table 2. The originally proposed test schedule included completion of all Unit 1 tests prior to carrying out Unit 2 parametric tests. It was decided that Unit 1 and Unit 2 parametric tests would be carried out sequentially during the first phase of testing scheduled for March 2004. This will provide a more cost-effective means to obtain information needed for determining operating conditions for the long-term test on Unit 1, scheduled for late Summer 2004.

In this program it has been proposed that existing carbon injection equipment be used to carry out the various tests in order to minimize overall costs. Thus, the availability of the injection equipment will impact the testing schedule. The current plans are to use an existing carbon storage & injection system currently being used at another plant in support of a NETL-funded program. This equipment will be available for use at Plant Yates after June 2004. Therefore, in order to perform the parametric test program during the next reporting period, a Porta-PAC injection system will be obtained from Norit Americas. This unit will be suitable for the short-term parametric tests on both units. Long-term testing will be carried out using the larger scale silo/injection skid system. It is anticipated that the long-term tests will start shortly after the skid is available in July 2004.

Table 2. Project Schedule.

Activity	Target Date
Initiate installation of Porta-Pac Injection Systems for Units 1 and 2	2/15/04
Initiate baseline testing – Unit 1	2/22/04
Initiate Parametric ACI Tests – Unit 1	3/01/04
Initiate Waste Analysis, Byproduct Evaluations	3/01/04
Complete Unit 1 parametric tests	3/13/04
Initiate baseline testing – Unit 2	3/15/04
Initiate parametric ACI tests – Unit 2	3/22/04
Complete Unit 2 Parametric Tests	3/27/04
Initiate Site Report/Presentation – Unit 1 & 2 Parametric Tests	3/27/04
Transfer/Install ACI Silo and Feeder System from Gaston to Yates Unit 1	7/15/04
Initiate Long-term Testing - Unit 1	8/1/04
Complete Long-term Test	9/15/04
Initiate Site Report/Presentation – Unit 1 Long-term Tests	9/15/04
Initiate Economic Analysis	9/15/04
Complete Data Work-up – Units 1 & 2	10/31/04
Complete Draft Site Reports - Units 1 & 2	12/31/04
Complete Waste Analysis Evaluations	12/31/04
Complete Economic Analysis	4/30/05
Complete Overall Data Analysis and Final Report	9/30/05

Sorbent Skid Design

Initial work designing the sorbent injection skid for use in the parametric tests was initiated during this reporting period. A description of the parametric test injection skid and conceptual lance design are provided below.

Sub-Contracts

A subcontract was issued during the current reporting period to ADA-Environmental Solutions, Incorporated (ADA-ES). ADA-ES is handling the skid design, installation, and operation tasks for this program and was proposed as key team members for this program in the initial proposal to NETL.

Task Activity Summary

Table 3 lists the current activity status of the primary tasks for this program. The Project Planning task has experienced some delays primarily associated with completion of the project test plan. The test plan will be finalized once a decision is made pertaining to carbon selection. This delay will not impact the planned test schedule at Plant Yates.

Table 3. Project Activity Status.

Task Number	Description	Planned % Completion	Actual % Completion
1	Project Planning	60%	40%
2	Plant Yates Unit 1 Testing	0%	0%
3	Plant Yates Unit 2 Testing	0%	0%
4	Economic Analysis	0%	0%
5	Byproducts Evaluation	0%	0%
6	Project Management & Reporting	12%	12%

Problems Encountered

There were no significant new problems encountered during the reporting period.

Plans for Next Reporting Period

The next reporting period covers the time-period January 1 through March 31, 2004. The primary activities planned for this period include completion of the project Test Plan and Quality Control Plan, mobilization of testing equipment and sorbents at Plant Yates, and parametric testing on Units 1 and 2. The mobilization effort will include installation of a Port-a Pac sorbent delivery system and the sorbent injection lances. Mercury measurement equipment will also be installed at the plant.

Baseline testing will be carried out on both Units 1 and 2. During these periods, mercury measurements will be made to evaluate current mercury emissions for both units under normal operation. Manual gas characterization measurements will be made to verify mercury analyzer results and determine particulate and halogen species concentrations in the flue gas. Fly ash samples will be obtained from the respective ESPs for future evaluation in NETL's byproduct mercury study.

Parametric activated carbon injection tests will be carried out on both units, as outlined in the project test plan. Norit America's FGD™ Carbon will be evaluated on both Units 1 and 2. An additional sorbent will also be evaluated on Unit 1. The parametric tests will evaluate the effects of sorbent addition rate and fly ash conditioning on mercury removal and ESP performance. The parametric test results will be used to determine the conditions to use during future long-term testing on Unit 1.

Prospects for Future Progress

During the subsequent reporting period (April 1 through June 30, 2004), no on site testing is planned at Plant Yates. Work activities will include breakdown of testing equipment used for the parametric test program. The Porta-PAC injection skid will be returned to Norit. Test data from the parametric tests will be worked up with various data trends analyzed; this will include

completion of analytical characterizations on gas and byproduct samples. A parametric data summary will be prepared and issued to the project team for review. A meeting will be scheduled to discuss the parametric results and plan the conditions for the long-term testing on Unit 1; it is anticipated that this meeting will be either held in conjunction with the DOE Contractors Meeting scheduled for July 14th in Pittsburgh or as a Web Cast meeting involving the entire project team.

EXPERIMENTAL

This technical progress report covers the first reporting period for this program. Activities performed to date have been primarily associated with kicking off and planning the project. Thus, no experimental work was conducted during this reporting period.

For the short-term parametric tests, a Porta-PAC sorbent injection system will be installed to service both the Unit 1 and Unit 2 ESP inlet injection points. This portable dry injection system, shown in Figure 1, pneumatically conveys a predetermined and adjustable amount of powdered activated carbon (PAC) from bulk bags into the flue gas stream via six sorbent injection lances. The unit consists of two eight-foot tall sections. When fully assembled, the Porta-PAC system has a total height of 16-feet. PAC is metered using a volumetric feeder into a pneumatic eductor, where the air supplied from the regenerative blower provides the motive force needed to transport the carbon to the final injection locations. The Porta-PAC can deliver from 20 – 350 lb/hr of activated carbon.

Figure 1. Porta-PAC Dosing Unit.

A conceptual design for the sorbent injection port configuration was completed following the site survey visit. Figure 2 illustrates the expected duct injection lance configuration for ACI tests performed on both Units 1 and 2. A more detailed experimental design will be completed prior to the test program and will be outlined in the project test plan.

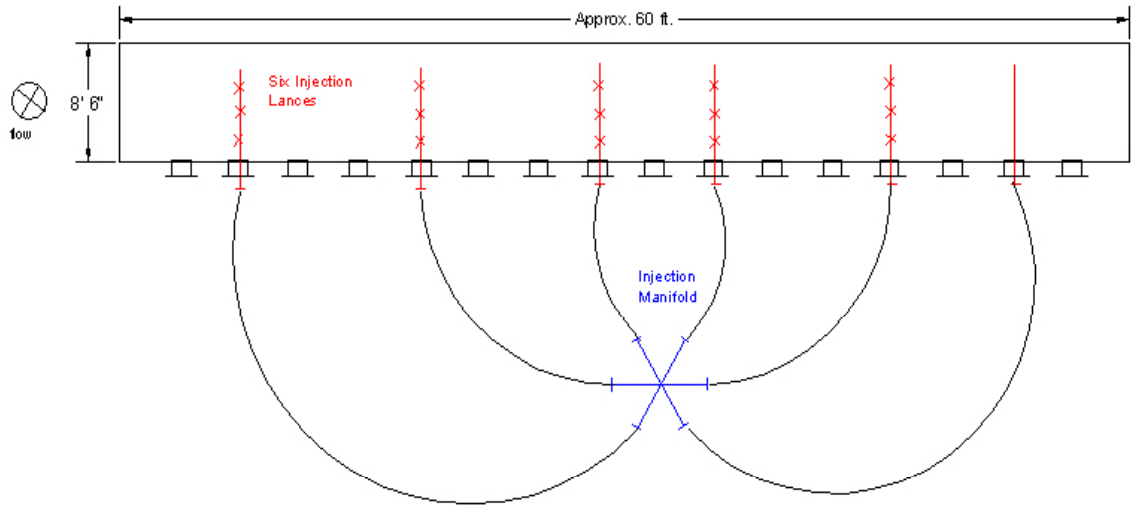

Figure 2. Sorbent Injection Port Configuration

RESULTS AND DISCUSSION

No technical results are yet available for this program.

CONCLUSION

Initial planning for this program, including a project kickoff meeting and a site visits to Plant Yates, was carried out during this first project reporting period. A draft design for the ACI injection system, to include use of a Porta-PAC dosing unit, was completed. A draft test plan is near completion and will be finalized pending the decision of which sorbent to test along with FGD™ carbon. Parametric ACI tests at Plant Yates are expected to be carried out during the next reporting period, as planned.